Foxton* Technology Pushes Processor Frequency, Application Performance

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Overview: Enhancing Workload Performance

A new Intel technology code named "Foxton" provides a mechanism for select Intel® Itanium® 2 processors to adjust core frequency during operation to boost application performance and make the most of available power. This capability will be available for the first time on the forthcoming dual-core Intel Itanium processor code named "Montecito," and will fundamentally change the way that developers consider frequency as a factor in software and hardware design.

Foxton Technology: Making the Most of Available Power

Commercial microprocessors are available in a variety of clock speeds, or frequencies. Although power is just one factor among many affecting microprocessor core frequency, it plays a significant role in determining the clock speed of floating-point operations, which are prevalent in scientific and technical computing, graphics rendering, and other computational-intensive applications.

In contrast, power plays a lesser role in determining the speed of integer operations, which constitute the bulk of enterprise applications such as databases, enterprise resource planning (ERP) applications and business intelligence applications. Such applications may not utilize the full amount of power available in the processor and ultimately run at less than optimum performance.

To address this dilemma, Intel has introduced a method that enables processors to adjust their clock speed opportunistically, between a base and a maximum frequency, depending on the operation being run. For power-hungry operations, such as floating point, the processor typically runs at base frequency, and for power-stingy operations, such as integer, the processor typically runs at higher than base frequency. For example, a processor with a base frequency of 1.6 GHz could have a maximum frequency of 1.8 GHz, depending on application power. This method, known as Foxton Technology, will be available for the first time in an Intel product on the upcoming Montecito processor.

How Foxton Technology Works

In a Montecito processor featuring Foxton Technology, an on-die voltmeter and ammeter measure power draw every 8 microseconds and adjust the processor frequency accordingly. If an operation is drawing less power than the processor is designed to handle, then Foxton Technology raises the clock speed in increments of roughly one percent until the processor reaches the power threshold or the maximum frequency, whichever comes first.

Conversely, if the operation is drawing more power than the processor is designed to handle, then Foxton Technology lowers the clock speed until the processor returns to levels within the power threshold or the base frequency, whichever comes first (Figure 1).

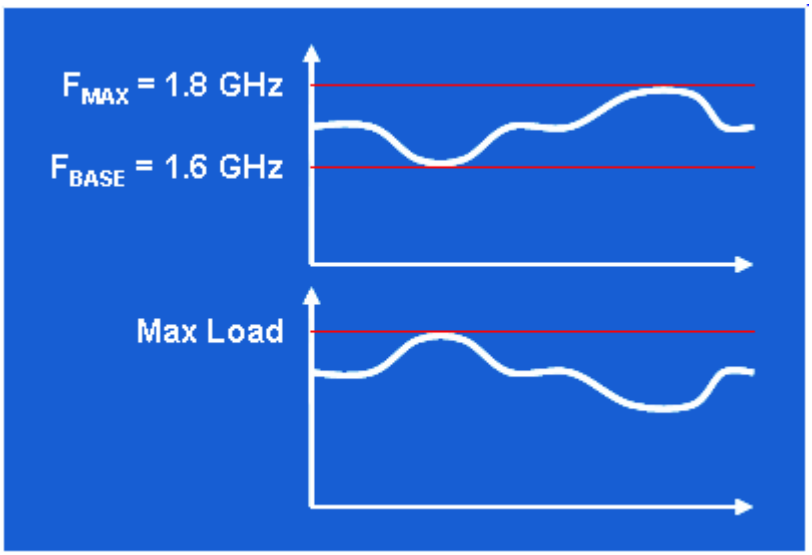

Figure 1. Foxton Technology adjusts processor frequency within power headroom to increase clock speed and achieve performance gains.

The goal of Foxton Technology is for the processor to maximize the performance of each operation, and of the overall application, per watt of available power. Foxton Technology is designed to provide performance benefits to all applications, but in general, enterprise applications tend to benefit more than technical applications. This is because the operations most common in enterprise applications require the simultaneous switching of fewer processor devices than the operations most common in technical applications, and therefore tend to draw less power per operation.

Challenges to Implementing Foxton Technology

The idea behind Foxton Technology is not a new one, but until recently this type of technology was difficult to implement. One challenge was the dynamic nature of silicon processor packaging. Due to thermal effects, packaging resistance changes constantly during operation, complicating real-time voltage and current measurements, much less adjustments. To overcome this challenge, Intel introduced an advance in measurement circuitry that continually recalibrates to new resistance values.

Another challenge involved the processor clock network, which synchronizes the timing of all the transistors on the processor—1.72 billion in the Montecito processor—and the data they are generating and exchanging. In the Montecito processor, this challenge was complicated by Hyper-Threading Technology† and the new Intel dual-core processors. To overcome this challenge, Intel developed a highly tunable clock network as well as a method of interfacing a fixed-frequency arbiter to the system bus and maintaining a fixed arbiter-to-bus frequency ratio.

More information about Foxton Technology will become available in the coming months.

Summary

Maximizing available power for every application is a challenge that has eluded processor designers for years. But thanks to recent advances at Intel in measurement circuitry and clock network technology, a technology is now available in a commercial microprocessor that adjusts clock speed based on the power draw of a given operation.

Foxton Technology, featured in the upcoming Montecito processor, measures power every eight microseconds and adjusts clock speed between a base and a maximum frequency. This enables applications to derive the highest possible performance per watt of available power.

More Info

Learn more at the Intel Web site:
Intel Itanium 2 processors
Intel® Platforms

Author Bio

John Wei is a technical marketing engineer in the Digital Enterprise Group at Intel Corporation. Since joining Intel in 1998, he has worked as part of the Itanium design team and has contributed toward a multi-bit ECC detection invention disclosure and a peer-to-peer network firewall traversal whitepaper. Wei holds a B.S.E. from the University of Michigan and an M.S.E. from the University of Michigan.

† Hyper-Threading Technology requires a computer system with an Intel® Pentium® 4 processor supporting Hyper-Threading Technology and an HT Technology enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. See http://www.intel.com/info/hyperthreading/ for more information including details on which processors support HT Technology.

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